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Compound eye of male *Stylops pacifica* (Strepsiptera; Stylopidae)

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INTRODUCTION

Few insect groups have greater sexual dimorphism than the Strepsiptera. With the exception of a single family (Mengeidae), the female is a completely passive endoparasite in a much larger insect, and nearly without the ususal external features of other insects (Gehrhardt 1939). These are reduced to a hint of segmentation on the abdomen and a few indeterminate pits and sutures on the sclerotized cephalothorax (Fig. 1). Copulation is said to be achieved *in situ* (Bohart 1941).

The male develops in a larval capsule similar to that of the female, but upon emergence is a small, unusually active, winged insect, about 3 mm long, already well sclerotized, short-lived and nervous, having many of its structures much modified. The antennae show development and variation between species and are well provided with large sensoria (Fig. 2).

The compound eyes of adult males appear to be somewhat primitive and are possibly of secondary importance to the insect. They resemble the eyes of thrips, collembolans, male coccids or the pupal eyes of some beetles (Pankrath 1890). There are no ocelli. Strohm (1910) suggested that each facet represents a lateral ocellus (ocellare komplexaugen), but Bohart (1941) pointed out that they may equally well have been reduced to their present form from normal compound eyes. Each optic unit resembles an ocellus rather than an ommatidium.

METHODS AND MATERIALS

Dr. J.W. McSwain, Instructor in Entomology at the University of California, Berkeley, caught and identified the insects as *Stylops pacifica* Bohart. He allowed me to accompany him into the hills above and behind the town on a fine afternoon in mid-March, 1951. We took eight bees (*Andrena complexa* Vier.) feeding on *Ranunculus*. All were parasitized with Strepsiptera, five with females including one bee with two, and three with males. One male was in the act of emerging. The material for study was put alive into Petrunkevitch fixer and held for a few weeks. The emergent male was the principal subject.

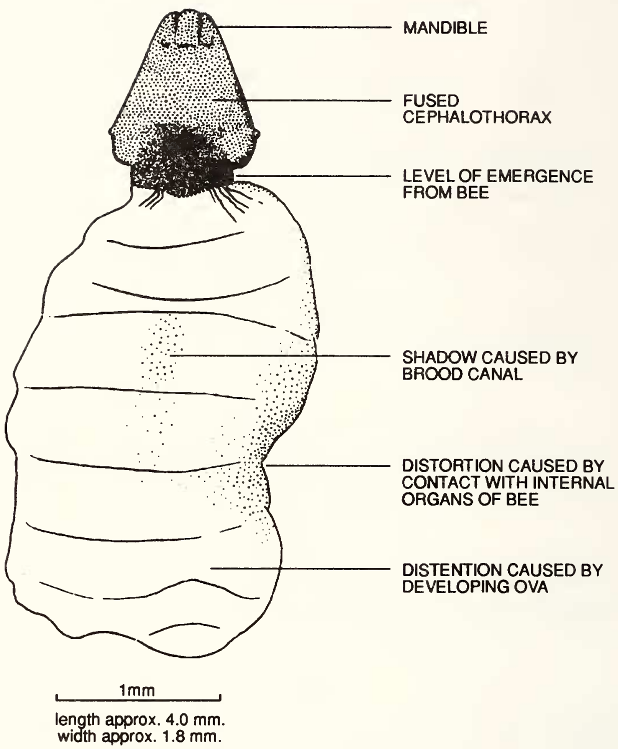

Figure 1. Adult female *S. pacificia.* Ventral aspect.

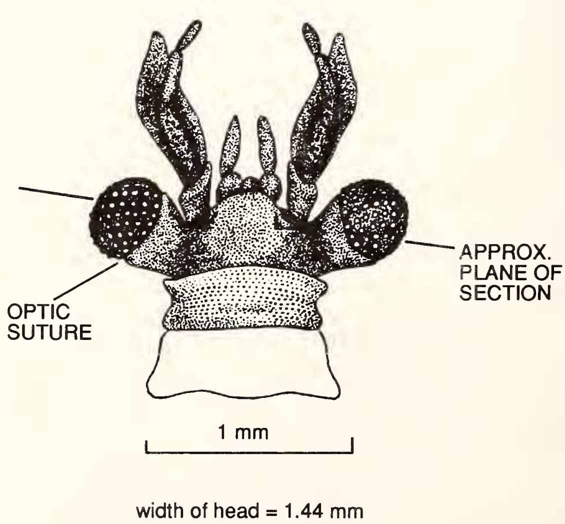

Figure 2. Head of adult male *S. pacifica,* showing compound eyes and antennae with sensoria.

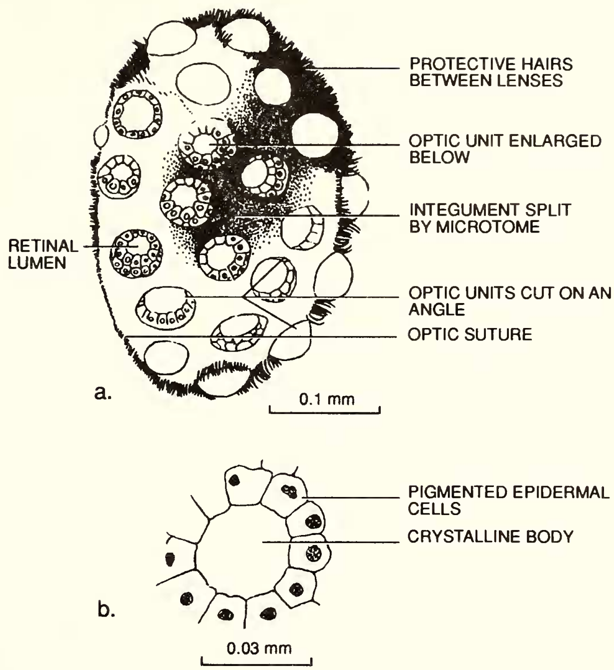

Figure 3. Compound eye of adult male *S. pacifica*, showing the separation of optic units (a) and detail of a single unit (b).

The histological treatment was unspecialized, designed to stain and counterstain as many cell types as possible. Dehydration and embedding started with ethyl alcohol from 70%, increased in five stages to 100%, each stage for 4 h, followed by three changes of xylene at various intervals. Paraffin was added to semi-fluidity and heated to 70°C for 4 h, then infiltrated further fresh paraffin for 2 h at 70°C in a vacuum chamber. The sections were cut transversely from the tip of the abdomen forward. Tests showed that haemotoxylin of pH 1.5 in 80% alcohol gave good results. The eosin stain was in 95% alcohol, at pH 7.0. The sections were never hydrated below 80% alcohol, and were mounted in Canada balsam.

RESULTS AND DISCUSSION

The head of the male *S. pacifica* is so wide in proportion to its length that the hemispherical compound eyes appear to be stalked (Fig. 2). Each eye has a deeply inflected optic suture (Figs. 2, 3, & 4). There are between 50 and 80 lenses per eye, which are not hexagonal but circular, glabrous, protuberant and well separated from one another by thickly pilose, heavily-pigmented integument (Fig. 4). The irregular biconvex shape of the lens suggests that these coarse hairs may play some part in shading it from oblique light rays (Figs. 3a & 5a,b), on the assumption that axial rays are the most important.

Within the lens a number of striae can be seen, a result of its laminar construction (Snodgrass 1935). These probably alter the refractive index of the lens, thus making it more difficult to work out a reliable optical scheme. A thick lens of this shape would have two principal points, the distances of which from their associated surfaces would depend upon the lens thickness, refractive index and both radii of curvature (Hausmann and Slack 1939). Using a single focal point a hypothetical optical system is proposed (Fig. 5b), which agrees with the interpretations of the tissues and their apparent functions.

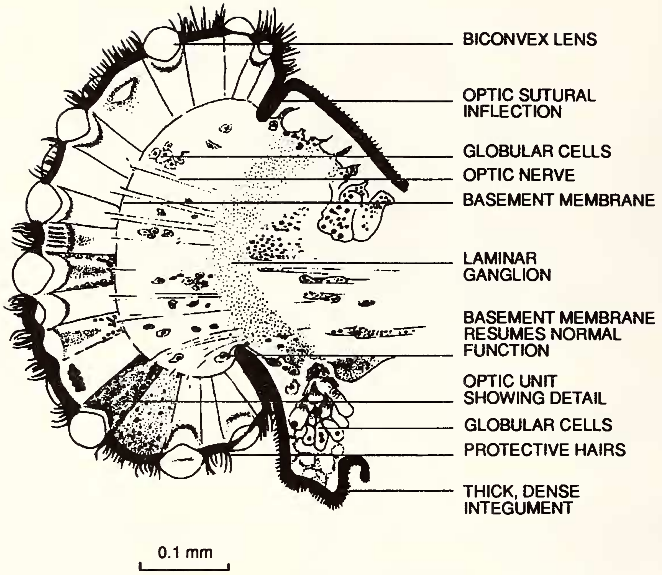

Figure 4. Compound eye of adult male *S. pacifica,* in lateral cross-section.

According to the lens formula, 1/p + 1/q = 1/f (where p = object distance, q = image distance, and f = focal length) and substituting values taken from the drawings, the object distance is found to be short. Male *S. pacifica* appear to be short-sighted.

Immediately beneath the integument in the specimen studied, each otic unit was surrounded by about 11 pigmented epidermal cells to a depth of three or four cells, or 30-40 cells per optic unit (Figs. 3a, b). At this level the units abut on one another in conventional, slightly irregular, hexagons. Beneath the lens and surrounded by the epidermal cells is a transparent crystalline body, apparently non-cellular, which may be formed as a secretion product of other cells (Snodgrass 1935). Below this again is a circle of granular, pigmented, corneagenous epithelium, without cell boundaries (Fig. 5a).

From this point proximally around the base of the unit, the cells change to rhabdomeres, or optic sense cells, with processes passing into the brain. There appear to be about 50 rhabdomeres per unit. There was not enough resolution to observe any neurofibrillae on the walls of the cells facing the retinal lumen (Hesse 1901). The lumen is non-nuclear with a fine-textured and variable darkening in the centre (Figs. 4 and 5a). The proximal processes of the rhabdomeres, or optic nerves, are prominent, each converging upon and passing through the basement membrance by way of a large opening. Around the base of each optic unit are apparently unspecialized mantle cells which may have no more than a nutritive or parenchymatous role.

The essentially epidermal nature of the eye is shown where the basement membrance (Figs. 4 and 5) passes directly to the integument at the optic sutural inflection (Fig. 4), there to resume its normal function underlying the epidermis. Within the brain there is a wide zone lying immediately beneath the basement membrane and traversed by the optic nerves, intersspersed with large globular cells (Fig. 4). A laminar ganglion follows proximally, succeeded by other brain tracts. No optic chiasma was seen.

NOTES

This study was an individual assignment in a course on morphology, given by Prof. Roderick Craig, when I was a student at the University of California at Berkeley, in 1951. It has been slightly edited and shortened.

According to the late Prof. G.J. Spencer (Proc. Ent. Soc. B.C. 48: 38, 1951), the late Hugh Leech "found stylopized bees freely in the arboretum" on the UBC campus. I know of no other mention in this province of these extraordinary insects.

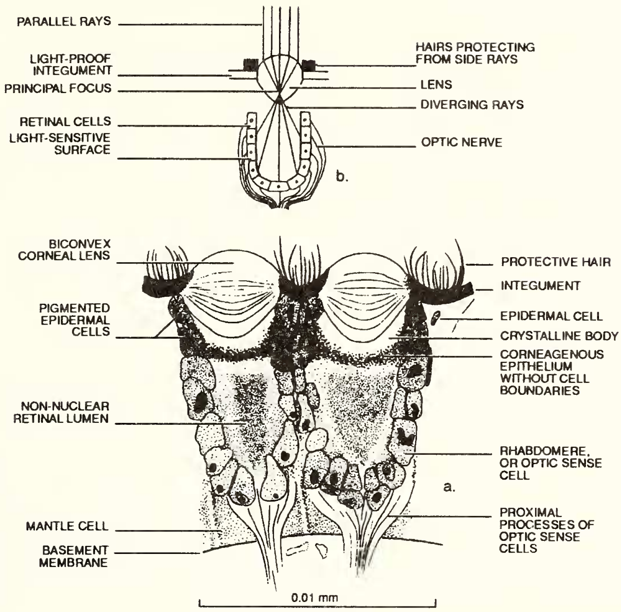

Figure 5. Compound eye of adult male *S. pacifica*. Longitudinal sections of two adjacent optic units (a) and theoretical optical system (b).

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Larvae of *Hyalophora euryalus kasloensis* (Lepidoptera: Saturniidae)

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There are no currently recognized subspecies of the ceanothus silkmoth, *Hyalophora euryalus* (Boisduval) (cf. Ferguson 1972, Lemaire 1978; see Packard 1914, McDunnough 1921 for discussion of specific synonyms); however, the status of *H. e. kasloensis* (Cockerell) has been debated for many years. The subspecific name *kasloensis* was published by T.D.A. Cockerell in Packard's (1914) monograph and was described as representing "a local [submelanic] race occurring in the interior of British Columbia" which was originally described, but not named, by Cockle (1908). Based on surveys of wild